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ABSTRACT

This publication is intended to provide college faculty and staff with a guide to information technology issues in higher education. Mid-Way through the 1990s, higher education confronts the second phase of the information technology (IT) revolution, a shift in emphasis from the computer as a desktop tool to the computer as a communications gateway. Major academic benefits are expected from increasing use of IT in the areas of content, curriculum, and pedagogy. For the academic year 1994-95, more than half of all entering freshmen were already familiar with an academic use of computing; because of this, IT has become another selling point for institutions as they compete for students. A growing number of faculty report improvements in the quality and effectiveness of their teaching by using IT, but investment in necessary support service staff are not keeping up with investments in technology. Use of the Internet is growing rapidly but access and use are uneven across and within campuses. However, the promises that IT would greatly improve productivity have yet to be realized. Today, it is in the areas of word processing, e-mail, and online information that IT is most common on campus. Many institutions are applying IT to new distance learning efforts. Institutions must plan how this technology will be used and must integrate IT into existing frameworks and goals. (Contains 10 reference notes.) (JLS)

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Information Technology: A Road to the Future?

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National Education Association

To Promote Academic Justice and Excellence

Information Technology:
A Bridge to the Future

Keith Geiger, President

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Preface

The National Education Association recognizes the advancement and application of instructional technology and high-technology devices and materials that provide new opportunities for developing skills, furthering research, and expanding knowledge in our society. (NEA Resolution, 1994, B-56)

This monograph is intended to provide faculty and staff with a guide to information technology issues in higher education. As technological advances are introduced into the academy, as campuses are more and more attracted by the promise and potential of technology for enhancing access and learning, faculty, staff and administrators need to understand what technology *can* and what it *cannot* do. Technology is seen by some trustees and administrators as the panacea for budget cuts; some see visions of hundreds of students sitting in front of monitors, with talking heads providing cheap, mass education. Other faculty, staff, and administrators see technology as a critical complement to the educational experience, opening more opportunities for the learner than can be encompassed by one campus. Both visions are possible, but the first not particularly desirable.

The parties need to develop a common understanding of technology's benefits and pitfalls, of the cost and process of implementation. It is hoped that this monograph will demystify technology issues, providing the parties with the framework to begin their discussions. The above NEA statement of principle provides a springboard for the development of policy concerning the introduction and use of information technology in a higher education setting.

The NEA Office of Higher Education invites your comments about this publication.

Keith Geiger
President

About the Authors

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This monograph is partially based on articles by the authors appearing in 1995 issues of *Change Magazine*.. However, many of the ideas offered here were first tested in both authors' presentations, consultations, and on the Internet Listserv AAHESGIT. To subscribe to the listserv, send an electronic mail message to

LISTPROC@LIST.CREN.NET in which the subject line is blank and the body is the single line (including no punctuation) SUBSCRIBE AAHESGIT yourfirstname yourlastname.

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Chapter 1. Introduction

Are you old enough to remember the slide rule? If handed one today, could you use it to perform simple math problems, let alone complex calculations?

Over the past fifteen years, computers have made the transition from the unique to the ubiquitous. Once the expensive, difficult tool of scientists and engineers, the desktop and notebook computer, far less expensive and far more powerful with each product generation, has become a staple of academic life: word processing and e-mail are core tools; the Internet is the digital lifeline that links colleagues across campus, countries, time-zones, and across the traditional barriers of time and location that restricted access to content and colleagues.

In this transition to the ubiquitous, our definitions and understanding of that technology have also experienced change. Computer specialists and librarians, not long ago members of campus cultures at odds with one another, are now finding common ground and together are exploring new frontiers in content, pedagogy, and technology. We speak less of computing and more about **information technology (IT)**, the former now perceived as narrow and the latter now understood in the language of campuses and corporations to be far more encompassing.

SIMPLE TRANSFORMATIONS

Are you old enough to remember the slide rule? If handed one today, could you use it to perform simple math problems, let alone complex calculations?

Early in the 1970s, calculators replaced slide-rules as the math tool of choice for scientists and engineers. Calculators are more accurate, easier to use, and generally do far more than slide-rules. After a few years on the market, calculators were less expensive than slide-rules. It was easier for students to

learn to use a calculator than a slide-rule. Less instruction was necessary. For colleges and universities, the transition costs from slide rule to calculator were low because students purchased their own. The transition decision was simple: a newer, more effective technology was available to replace an older, less useful tool. It was not necessary to conduct time-consuming, expensive, cost-benefit analyses or learning outcome evaluations of slide-rules and calculators.

Calculators — both the inexpensive products and the high-end, programmable models widely used by scientists, engineers, and financial analysts — provide an interesting case study of a compelling technology that helped change the way many professionals work. Moreover, this technology, by general consensus, helped its users become more "productive." The *personal productivity* value of the calculator was readily apparent. However, this technology changed only a small part of what was taught and how it was taught, and the changes applied primarily to specific disciplines, not the whole academic enterprise. Advocates did not believe or claim that higher education as a whole or that individual colleges or universities had become more productive because more students and faculty were using calculators.

The case-study of the calculator suggests several major points about the integration of technology in education. First, the most compelling technological innovations do not require extensive analysis or evaluation before they become widely adopted and integrated into the curriculum. The calculator, and especially the programmable calculator, was a compelling technological innovation.

Second, the universe of beneficiaries must be carefully identified in any and all discussions about impacts, including productivity. For example, a new technology may offer significant productivity gains for individual students or faculty without affecting institutional productivity; alternatively, technology may be used to increase the productivity of administrative operations without having any impact on instruction.

Third, compelling technology may — or may not — have dramatic consequences for the curriculum. Neither calculator advocates nor calculator vendors made great claims for how

these products would change engineering education. But clearly the programmable calculator has contributed to some important changes in mathematics, engineering and technical education over the past two decades, and not all these changes were initially identified or anticipated. Similarly, the computer spreadsheet has also had important impacts on management education, but advocates made no great claims. Here too, many of the impacts and benefits were not initially identified or anticipated.

Finally, the experience with the calculator is unusual. The slide rule, like the book, blackboard and lecture, was an accepted standard. But unlike the book, blackboard and lecture, the slide rule was quickly replaced by compelling new technology — the calculator. Today, given great claims for computers, video, and IT, for better or worse, the book, blackboard, and lecture continue to dominate instruction.

GREAT EXPECTATIONS

Education has always seemed attracted by the promise and potential of technology. From film in the 1920s to television in the late 1950s, computers in the 1980s, and now information technology in the 1990s, the public has heard great expectations for the use of new technologies that might enhance learning and instruction. In the 1980s, during the much discussed "microcomputer revolution" in higher education, the computer emerged as a personal tool: writing across all disciplines, financial analysis in business, statistical analysis in the social sciences. Students, faculty, and institutions purchased desktop systems by the truckload; engaging applications (initially word processing and spreadsheet, later graphics, digital imaging, desktop publishing, electronic mail, multimedia), falling prices, and increased power and convenience brought the desktop and notebook computer to thousands of academics who never previously thought of themselves as "computer users."[1] Most would agree that modest productivity benefits emerged as growing numbers of faculty transferred much of their work from secretaries, mainframes, and minicomputers to desktop systems and word processors.

Midway through the 1990s, however, colleges and universities confront a second major phase of this revolution — a shift in emphasis from the computer as a *desktop tool* to the computer as the *communications gateway* to colleagues and information — data bases, image and text libraries, videos, and other content sources increasingly accessible via computer networks to both faculty and students. Technology advocates are fond of describing a future information-rich environment that will support instructional and scholarly activities in new and exciting ways.

Additionally, the rising financial pressures confronting higher education in recent years have also focused attention on the promise of technology to improve productivity in higher education. The stated hope is that computing and information technologies will yield new levels of institutional and instructional "productivity." The stated expectation is that the infusion or integration of new technologies into instruction will, at minimum, maintain and ideally enhance student learning while significantly reducing instructional costs.

But will information technology lead to the kinds of productivity gains and associated cost savings touted by its most ardent advocates? Alas, not soon, and certainly not soon enough for those both in and out of academe who are understandably eager to control instructional costs nor for the evangelists who promise that information technology will enhance faculty productivity.

However, a careful review suggests there will be major substantive benefits from more widespread academic uses of information technologies in the areas of content, curriculum, and pedagogy. Further, the demands and expectations of students and faculty for technology resources are increasing the pressure on colleges and universities to make information technology readily available. Finally, the number of students who can benefit most from new distance education applications of technology has been steadily increasing.

Chapter 2.
The Campus Environment

For the academic year 1994-95, more than half of entering freshmen were already familiar with an academic use of computing.

The national system of schools, colleges, and universities is undergoing a major transformation. This transformation is inevitable, irreversible, and unpredictable, although we can still influence its direction. The emergence of new information technologies is neither the cause, the purpose, nor the consequence of this transformation. What follows is a list of "symptoms" — indicators of that societal transformation and how that transformation manifests itself on campus.

FACULTY AND STUDENTS

Many experienced, conscientious faculty members report that their best teaching efforts "just aren't working as well any more." A growing minority of faculty members (up to 15%) report significant improvements in the quality and effectiveness of their teaching by using applications of information technology.[2] However, many other faculty members are reluctant to move beyond word-processing because they believe (wrongly) that information technology will not be terribly important for the courses they teach for the next five to ten years. Faculty use of custom publishing ("course packs") is growing quickly from a very small base. Many leading textbook publishing companies are investing in experiments with non-print media, especially CD-ROMs. Most traditional publishers are more worried than enthusiastic about delivering text over the Internet.

Publishers and college bookstore managers report that one-third or more students do not purchase the "required" textbooks for courses in which they enroll. Most students no longer think of the books they buy for courses as resources to

be kept and used after the course is completed. For the academic year 1994-95, more than half of entering freshmen were already familiar with an academic use of computing. Almost 25% of all students own computers. About half of all faculty members had easy, frequent access to a microcomputer. The base of microcomputers in homes is growing fast — and many of those home machines are more powerful and multimedia-capable than the ones back on campus.

FACULTY ADOPTION AND SUPPORT SERVICES

New campus investments in computers, video equipment, and software are most often not matched by new additions to technology/media support service staff. As the availability of equipment and publicity about the Internet increases, the demand for training and other support services increases at an accelerating pace, and the gap between demand and availability of support services widens.

A faculty member cannot adopt a combination of new teaching approach, application of technology, and instructional materials as easily as he/she might pick a new textbook for a course. There is no longer any single comprehensive source of information about relevant instructional materials for most courses. Even if the faculty member could obtain a "review copy," a technological instructional asset cannot be skimmed and evaluated in the same way as a book or article. It is still quite rare for a faculty member to have had direct personal experience as a student or observer in a course where new applications of information technology were successfully used by the instructor. It is almost as rare for a faculty member to have had training in the instructional uses of information technology. If use of the Internet as a source of student access to course-relevant information is included in a course presentation, the advice and skills of an Internet-savvy librarian are essential.

The availability of hardware and physical plant resources becomes crucial to the success of technology adoption. If the intended instructional methodology includes faculty and/or student use of new application of information technology, then

the accessibility of relevant hardware, software, training in its use, and its maintenance are also essential. Traditional classroom physical layouts and class meeting schedules are often inappropriate for teaching approaches that emphasize collaborative work among students, project-centered learning, or extensive use of some instructional applications of technology. Many of the attractive new options cannot be adopted unilaterally by a single faculty member; they require resources that would be hard to justify for a single course. The commitment to technology must be *at least* department-wide.

TEACHING, LEARNING, AND TECHNOLOGY COMBINATIONS

The vast majority of colleges and universities now have some form of connection to the Internet. However, an institutional connection to the Internet does not always translate into student and faculty access, particularly in smaller institutions and community colleges. Moreover, the costs of infrastructure and user support, coupled with campus norms, missions, and culture, affect the manner in which institutions provide Internet access to students, faculty, administrators, and staff. Consequently, it is almost impossible to keep track of the growth rate in student and faculty use of the Internet, other than to say that is in indeed growing, by leaps and bounds.

In higher education, the rate of growth in use of the World Wide Web appears to be even greater than for other populations. Observers are beginning to note that anyone who develops a "home page" on the Web is actually creating a "multimedia" presentation. Any faculty member who chooses to make course-related materials available to students as part of his/her own home page — a practice that has just begun and is spreading — is actually opening the door to a new form of "distance education." Those materials become accessible throughout the world to anyone who finds them.

The number of faculty using electronic mail in otherwise conventional courses is growing rapidly. With e-mail, many faculty members report better communication with students about the subject matter of the course. They report also that

course-related uses of e-mail significantly increased their own workload.

New combinations of teaching approach, applications of technology, and instructional materials are emerging and gaining advocates; collaborative/cooperative learning provides an exciting example. In both, students work in small groups as an important element of the learning process. Recently, some campus experiments have begun to use groupware in support of collaborative/cooperative learning. In the field of English composition, software systems for working together on papers have been in use for several years.

INSTITUTIONS AND ACADEMIC LEADERS

Many academic leaders believe (in many cases, incorrectly) that their institution is sadly behind in the academic use of information technology. Many presidents and chief academic officers are approving major investments in information technology based on the (misguided) belief that real cost savings in instruction will be achieved in a year or two or three, even as they claim that such gains will be achieved without reducing the number of full-time faculty. Some institutions are leaping at "distance education" as a near-term solution to financial and other problems — without taking the necessary time to understand all that is required and to prepare faculty for effective participation. Some institutional leaders seem not to realize that an approach that appears to eliminate the need for most of the faculty could also, by extension, eliminate the need for the college.

Chapter 3.
Technology and the Quest for Productivity

Institutions must not continue to underestimate the real costs, complexity, and duration of the successful implementation process. Without understanding these cycles and their costs, campuses will neither recognize nor attain the full benefits that technology might offer to students, faculty, curriculum, and institutional effectiveness.

Reduced to the core issue, the "technology yields instructional productivity" advocates are eager to demonstrate that information technology will (a) allow the same number of faculty to "teach" more students at the current (or at an enhanced) level of learning or (b) allow campuses to serve the same number of students with fewer faculty and with no loss in learning (either what is learned or the number of students who learn it).

Clearly technology has brought both enhanced *institutional* productivity and reduced costs to some parts of higher education. Like many corporations, campuses routinely and effectively use technology in many administrative areas. As in the corporate domain, computers have improved productivity related to a wide range of data management and transaction processing activities: personnel files, course schedules, library catalogs, budgets and accounts receivable, student transcripts and admissions information. Moreover, in some parts of the faculty domain, technology has truly helped to increase productivity and reduce operating costs. Indeed, a generation of faculty has come into academic positions with little or no secretarial assistance from their departments or institutions: they have a computer to prepare their own class materials, course syllabi, conference papers, grant proposals, manuscripts, and other documents.

As yet, however, relatively few would claim — even after a dozen years into the "micro" revolution — any real gains in

instructional productivity. In that realm, as ever, we are still left with the "promise" of technology. To understand why we find more potential than performance, it is instructive to examine the wider literature on technology and productivity, most of it based on the experience of corporations and not-for-profit organizations.

IMPLEMENTATION CYCLE

Implementation cycle research points to four stages of IT integration that occur over years, not weeks or months:

Stage 1. Some planning, investigation, and experimentation takes place. There is recognition that the leading competitors (peer institutions, in the case of higher education) have already started to use technology. There is the recognition by some individuals that they can do some of their work better and faster if they can use the most widely available functions of a desktop computer. A decision is made to permit small groups to go ahead with experiments or to ignore the fact that they already have done so.

Stage 2. Next come a few years of marked increase in planned capital investment for individual workers/ professionals and surprising increases in operating expenses — with little reduction in other expenses. Additionally, there are unanticipated but significant delays in implementing some of the most "obvious" applications. The organization also slowly begins to accomplish some tasks never before attempted and experiences a modest gain in the scale or scope of new activities.

Stage 3. A few years of readjustment ensue, where costs and annual investments in technology stabilize while capacity continues to grow and new functions are developed and implemented.

Stage 4. Finally, there are several years where the organization achieves new levels of efficiency and effectiveness — but the organization is no longer really in quite the same "business" it was in the beginning. No one seriously asks if technology-increased productivity compares with the previous ways of working, because the organization is no longer pursuing the old objectives and no longer works in the old way. No one seriously considers abandoning the technology, because it has become inconceivable to accomplish what is now being done without it.

In academic administration, financial management, and other areas where educational institutions engage in functions highly similar to corporations, colleges and universities can adopt techniques already well-developed for business and move very rapidly through, or perhaps even skip, the earliest stages. In instructional areas, however, the IT decisions of colleges and universities are more decentralized than in corporations; moreover, the core functions are not similar to those in business. Consequently, the organizational implementation cycle is more complex and educational organizations are likely to move through the stages even more slowly than industrial organizations of the same size.

On the academic side, most colleges and universities are somewhere in Phase 1 or 2 — spending money. Just the same, new technologies that may offer great potential for educational applications continue to arrive — each year, each month, and sometimes each week. With each major new technology, institutions and departments must again revisit plans and move through the same stages.

Higher education has much to learn about the turnover of technologies and how to move quickly and painlessly into stages 3 and 4 cited above. Additionally, it needs better models to measure the costs and benefits of technological innovation on instruction.[3] All the while, the current technology infrastructure at most institutions is so taxed and under-funded that campuses are stretched supporting just the "early adopters," the first large wave of students and faculty drawn to

desktop computing and IT resources.[4]

Institutions must not continue to underestimate the real costs, complexity, and duration of the successful implementation process. Without understanding these cycles and their costs, campuses will neither recognize nor attain the full benefits that technology might offer to students, faculty, curriculum, and institutional effectiveness. The consequence: campuses will be stuck in stages 1 and 2, never achieving the gains available in stages 3 and 4.

One example of this problem is in the costs of installing a campus network, an issue which most campuses have experienced or will soon confront. At face value, the costs are running wires into offices, dorms, libraries, and classrooms. But the additional and very real implementation costs include additional equipment, initial user training, continuing user support, and software licenses. Moreover, while the initial installation cost looks like simple capital expenditure, the technical maintenance and user support costs are a continuing expense; over a few years these recurring costs can easily dwarf the initial installation expenses. Estimates received by campus administrators for "running the wire" seldom are total costs. The ancillary or support costs can easily triple the original expense. These costs are ongoing, and must be built into an institution's budget year after year. Technology does not provide a quick financial fix for an institution or an academic program seeking to increase productivity, revenues, or quality.

There is another lesson from the corporate experience that is also important for higher education. The successful integration of information technologies is almost always associated with significant *structural* change. In contrast to the pace of corporate restructuring in the United States over the past five years, structural change in education occurs slowly, incrementally, and over a period of many years. Indeed, it is well-known that the collegial decision process works far better at preserving culture and knowledge than at responding quickly to new technologies and changing environmental issues. Yet given the pressures currently confronting educational institutions — for accountability, quality, cost control, productivity, and organizational efficiency — colleges and universities may have arrived

at the moment when they *must* shift to accommodate change as well as preservation.

Some IT advocates, those strongly committed to applications of specific technology, may argue with this critique. Some will point to individual cases in specific disciplines where technology helped to increase productivity and/or reduce costs. Some will argue that successful structural changes are already underway, citing distance education as the most important example.

But these changes do not necessarily address the core, campus-based instructional activities of most faculty at most institutions. Rather, the oft-cited examples of successful integration and potential productivity gains (or effective cost control) typically involve small programs, early adopter faculty, and units that receive special support as part of a pilot program. We have yet to hear of an instance where the total costs (including all realistically amortized capital investments and development expenses, plus reasonable estimates for faculty and support staff time) associated with teaching some unit to some group of students actually decline while maintaining the quality of learning.

What does it cost to support instruction in a classroom? Much depends on the kinds of technology in use. A 4'x8' white board costs approximately $150, an overhead projector $350, a multimedia computer w/projection via overhead projector $2,700 and a 20 unit networked computer lab with projection device $60,000. These costs represent just the initial purchase price, not sustained support and operating costs. The three year costs for a 4'x8' white board might be $100 for markers, erasers and cleaning fluid. In contrast, the three year costs for a single unit multimedia computer/projection system could easily surpass purchase costs, given software upgrades and some technical assistance. One other important point is that the white board is less susceptible to obsolescence than the multimedia computer system or 20 unit instructional computer lab.

Chapter 4.
Motivating Behaviors

The old competitive reference points describing information resources that used to distinguish between institutions — the number of science labs and library books — are being replaced by a new one: information resources and tools available to students.

Given the somewhat uncertain benefits, why do (or must) colleges and universities invest in information technology, even if the claims for productivity are elusive or just simply a long way off?

There are several compelling reasons why institutions will have to make continuing and significant investments in information technology. These reasons generally fall into three categories: competitive position; teaching, learning, and curriculum enhancement; and student preparation for the labor market.

COMPETITIVE POSITION

Growing numbers of college-bound students come to campus with computer skills and technology expectations. In Fall 1994 over half (55 percent) of all entering college freshmen reported having had at minimum one-half year of some form of formal computing or technology instruction while in high school.[5] Several recent consumer studies suggest that one-fourth to one-third of American households now own a computer and more than 40 percent of recent computer sales in the United States have been into homes rather than small businesses and large corporations.

Consequently, colleges and universities must invest in computers and information technology if only to tell their potential clientele that the institution provides the same information technology resources increasingly available elsewhere, in homes and high schools and at competing institutions. Given the explosive growth in home computer sales over the

past years, many students will arrive on campus to find old or antiquated computers in campus labs and clusters. In contrast, the computers students have at home, in their dorm rooms, and in off-campus apartments will be newer and more powerful than the systems available to them on campus.

But since the network and on-line information resources now drive much of campus computing, the continuing institutional investment will focus heavily on the network, particularly "plug and play" options that allow mobile users to connect devices into the campus network at a variety of locations — libraries, labs, dorm rooms, offices. The old competitive reference points describing information resources that used to distinguish between institutions — the numbers of science labs and library books — are being be replaced by a new one: information resources and tools available to students, as reflected by (a) the number of locations on and adjacent to campus that support mobile computing and network access; and (b) the kinds, quality, and currency of digital resources available on-line via the campus library or information services center. As evidence of this transition, simply spend a few minutes with a standard college guidebook to see the kinds of information these resources now provide about the campus computing and IT environment. These competitive issues also apply to institutional efforts to recruit and retain faculty.

TEACHING, LEARNING, AND CURRICULUM ENHANCEMENT

There is impressive evidence that information technology can be used to enhance courses, curriculum, and student learning. One of the best articles on this topic, by Robert Kozma and Jerome Johnston, presents compelling evidence, drawn from a number of disciplines and a variety of campuses, about the role of information technology as a catalyst for (or enabler of) the qualitative enhancement of the learning experience.[6] Summarized below, Kozma and Johnston identify seven ways that computing and information technology can be used in the transformation of teaching, learning, and the curriculum:

1. *From reception to engagement.* The passive model of learning in higher education is changing. No longer will the student simply soak up knowledge from lectures by faculty or from library texts. Students, instead, will become actively engaged in the discovery of knowledge.

2. *From the classroom to the real world.* Students leave higher education with an intimate knowledge of the intellectual, social, and work world situations and contexts. The classroom will be open to an examination of real-world considerations as technology breaches the walls between classroom and the "real" world.

3. *From text to multiple representations.* Information technology will expand communication beyond simple text or speech representation into other symbolic systems.

4. *From coverage to mastery.* Computers can expand the classroom experience by giving students the opportunity, through drill and practice, to achieve mastery in essential skills and concepts.

5. *From isolation to interconnection.* Technology provides the opportunity for students to move from individual to collaborative learning, from "the consideration of ideas in isolation to an examination of their meaning" in a global context.

6. *From products to process.* Students will learn how to use the tools of scholarship. Critical thinking ability will become more important than the product in the educational process.

7. *From mechanics to understanding in the laboratory.* "The scientific laboratory is one of the most expensive instructional areas of the academy. It is costly to maintain — and to provide supervision to student scientists. It is also a limited learning experience [as] so much time

is spent replicating classic experiments that there is little time left to explore alternative hypotheses as real scientists do."[7]

There are many ways that information technology can enhance the undergraduate curriculum and student learning experience. The key issue, of course, is the effective use of information technology resources as *tools* to support instruction and learning outcomes.

There are now good examples to document the successful use of computer software to improve the *quality* of learning and teaching in each of the categories described above. Kozma and Johnson report from their work with the faculty who received national recognition from the EDUCOM/NCRIPTAL Higher Education Software Awards Program that most award winners needed five to seven years to develop their own instructional applications. Students in the classes of these faculty benefited significantly from the faculty effort to develop instructional software. But overall, Kozma and Johnston report minimal dissemination and adoption: comparatively few students, courses, or other institutions ever benefited directly from that work.

Focus for a moment on just the classes where faculty used the EDUCOM/NCRIPTAL award software to support instruction. Were it possible to accurately calculate (or even estimate) the increases in student learning linked to these instructional resources, the "productivity gains" *for individual students* would produce impressive numbers. Students in these classes were usually not required to pay additional fees or invest much additional time, but they were enabled to learn more — to learn it faster, better, more comprehensively. *Improved outcomes divided by stable costs generated increased productivity.*

However, calculating productivity gains for any broader universe — even at the level of the individual course — will not show such gains. This second set of calculations would have to include total development costs — the faculty time and related institutional support. This more accurate assessment of total costs dramatically reduces the relevant cost-benefit ratio.

Moreover, the true development costs are quite large if spread over only a few hundred or even a few thousand students.

LABOR MARKET PREPARATION

There is no question that technology skills will be essential in ever increasing sectors of the labor market of the 21st Century. The use of computer and other information technologies is becoming prevalent across all fields and occupations. Consequently, colleges and universities would be doing a major disservice to their students if the institutions failed to provide appropriate opportunities (including structured curricular experiences) to develop and enhance information technology skills as part of an undergraduate experience.

In this context one of the best statements comes not from an occupational task force or industry group but from the American Library Association:

> To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.... Ultimately, information-literate people are those who have learned how to learn. They know how to learn because they know how knowledge is organized, how to find information, and how to use information in such a way that others can learn from them. They are people prepared for life-long learning, because they can always find the information needed for any task or decision.[8]

Information access, or *information literacy* (to use the ALA term), will be important for the growing cadre of knowledge workers and professionals in the 21st Century. These challenges cut across all academic disciplines and across all occupational and professional fields. It is an issue higher education institutions across the United States cannot ignore — but one that many faculty have no idea how to address and for which few teaching materials have been designed. It is an area where communication, cooperation, and collaboration among faculty, support staff, and librarians will be essential.

LIMITATIONS

So there are good reasons other than institutional productivity for colleges and universities to invest in information technology for teaching and learning. These reasons, described above, can be explained in terms of productivity gains for individual faculty and, especially, to individual students. But these gains do not offer the kind of progress described in implementation stages 3 and 4. Many colleges and universities confront pressures that force them to seek much greater gains (and the accompanying reduced costs).

So why are institutions not making more progress towards stages 3 and 4? Infrastructure and user support limitations are the central issues preventing colleges and universities from reaching stages 3 and 4 in the educational use of information technology. Most campuses have barely begun to provide the capital and operating investment — computers, telecommunications links, adequate technical support staff — required to support significant gains based on the effective integration of information technology. When user support levels (personnel and dollars) are compared to widely cited standards for corporations, colleges and universities are often running at one-half to one-fifth, or less, of recommended levels. This highlights the often hidden, often unacknowledged, but nonetheless real costs of user support as a key component of the overall costs of the institutional investment in IT.

Moreover, many senior campus officials view the technology infrastructure — equipment, software, and support personnel — as a "black hole" for money. They often view IT as a centralized service (similar to the library) that is an easy target for budget cuts in times of financial difficulty. Additionally, technology resources are expensive yet have a short half-life, often less than 15 months. Most campuses do not have an amortization plan for acquiring and retiring needed equipment and software that becomes obsolete quickly.[9]

Many campuses fit a pattern that leads to a crisis in this area. Increasing investments (campus dollars or external grants) support the expansion of the information technology hardware base on campus. Little attention is given to the

accompanying increased demand for technical support personnel who keep the new additions functional. Meanwhile, as more students and faculty notice the arrival of the gizmos, widgets, and stuff, they begin to ask "How can I use that new jack in the wall? When can I use this Internet I hear so much about? Who will train me to use Netscape Navigator? How soon before I can bring this into my classroom?" At the same time, institutional financial pressures have led to a hiring freeze or staff reductions. Faculty who have depended on technical support staff for basic services find support less accessible. Faculty eager to explore IT applications in their instructional and scholarly work experience problems because the support staff who handle technical issues or training are simply not available.

What then happens when institutional pressure increases to support distance education and other *pedagogical* and *content* changes? The need for additional faculty support services to facilitate these major transitions increases and becomes still more varied and extensive and often is recognized too late. Pedagogical change enabled by technology requires faculty development services that help faculty understand, adapt, and adopt new teaching approaches. As many of the new pedagogical approaches rely on new ways for students to access new kinds of information resources, increased and more sophisticated library support services are also required.

The all too-likely and unfortunate outcome is that user support (training, assistance) declines just when faculty interest and aspirations might increase. The hopes for engaging, significant, and exciting changes in academic activities, enabled by technology, are unfulfilled as the gap between the level of support services needed and the level available widens. The institution remains stuck in stages 1 or 2.

There is another important dimension to this discussion. Amidst all the conversation about using IT to enhance instructional productivity, the client's perspective seems missing. *How much and what kinds of IT do the clients — students —view as essential, beneficial and/or convenient?* How much and what kinds of IT do they view as serving faculty or institutional interests, rather than their own?

The 14.5 million students enrolled in U. S. colleges and universities represent many different markets for educational training and services, ranging from full-time freshmen and medical students to part-time students in community colleges and in MBA programs. Instructional models and technologies appropriate for and effective with some populations or in some disciplines may not work well for others.

Some interesting innovations such as Mind Extension University (MEU) use cable to bring college courses into homes at all hours of the day. MEU students can tape the lectures for viewing at a more convenient time, much the way many traditional students might copy reserve reading assignments. But even with dramatic growth, MEU serves a very small percentage of the clientele for higher education in the United States. Part of MEU's costs are leveraged, because it distributes content — video courses — developed by faculty based at traditional campuses across the country. For MEU's clients, cable offers added-value, traditional content plus significant convenience. Similarly, for MEU's suppliers (participating faculty and institutions), MEU's distribution agreements represent added-value in the form of new markets that expand the potential for new clients.

But the IT that provides added-value to MEU's clientele can also be inappropriate, impersonalized (and potentially overpriced) instruction for eighteen-year-old college freshmen and executive MBA students. In short, IT is not a "one-context serves all" solution. *However, the kinds of productivity gains or cost savings promised by advocates requires a mass, rather than unique application of the resource.*

Those who believe that technology provides the "silver bullet" on productivity and quality should look at the experience of General Motors during the early 1980s. Seeking a quick fix to quality and productivity problems, GM invested heavily to bring technology to its manufacturing plants. By one estimate GM spent $50 billion on automated assembly lines and robots. A decade later GM could report only marginal gains in quality and productivity; moreover, GM continued to lose market share and fall behind on quality to its Japanese and United States competitors. In contrast, a visit to Ford's assembly lines reveals only average use of robotics in manufacturing and

assembly, yet its quality and market share improved.

What happened? Why did GM fail to realize quick, real benefits from its massive investment in technology? The problem was that GM poured money into technology but paid little attention to the overall design process: the new technology on the assembly line could not resolve key design problems in the product. The GM experience, widely cited in TQM circles, highlights the role of technology as one of *many* tools, rather than *the* tool, to enhance quality and improve productivity. Moreover, at GM as in higher education, process and participation are important: training, worker (or user) participation, design, client needs and requirements, and support services for professionals all affect outcomes — be it car quality or classroom learning.

The real long-term academic benefit of information technology will be what it brings to pedagogy and the curriculum — additional resources that enhance the instructional tools used by faculty and the learning experience of students. Ample evidence documents the benefits for the learning experience. Technology provides access to image data bases (satellite photos of the cosmos or the California coastline), statistical data bases (such as Census data) that students can use for class projects, remote libraries (which supplement resources available from campus facilities), and more.

It is in this context that the IT implementation effort now underway at colleges and universities across the country poses two great risks:

1. Many institutions will focus on technology, with inadequate attention to other components of the process. This will lead to marginal (if any) gains, great individual and organizational frustration, and, ultimately, to unrealized potential;

2. Only a few institutions will have the financial and personnel resources and the commitment necessary to achieve the educational potential of information technology — providing access to superior learning options for students and new levels of faculty productivity.

Despite the time and money invested to date, colleges and universities are still in the flat part of the learning curve in the area of information technology. Institutions, departments, and faculty are still experimenting with using familiar technologies in new and different ways, with both traditional and new clientele. Additionally, past experience suggests that new technologies always generate unanticipated applications and benefits. In other words, the wisest technology advocate or planner cannot anticipate all the ways that new technologies might be used to enhance instruction and scholarship.

Chapter 5.
Change and Expectation

Colleges and universities still have much to learn about how to develop a new information technology infrastructure that provides instructional and curricular benefits. We must measure our great aspirations and institutional investments against what information technology can really provide, not what we hope (or fear) it might do.

Even as many institutions struggle to develop their technology plans and articulate a vision for the way they intend to use IT, the daily importance of IT in higher education is readily apparent, if not yet pervasive. Over the past decade, and in particular within the past five years, IT has become common within the academic enterprise.

- Computers have replaced typewriters. Word processing is now the primary mechanism for preparing the documents — class assignments, institutional reports, and scholarly documents — that are the coin of the realm in academe.

- E-mail has emerged as a major resource for scholarly communication. The dissemination of ideas and documents via the Net has contributed to new levels of scholarly access and dissemination in many fields.

- On-line information resources provide remote access to a rich array of content. Gopher and World Wide Web (WWW) resources bring distant data and archival material to individual desktops via the magic of the network.

- Video distribution supporting distance learning transfers the content of one classroom to many. Using conventional telephone lines, fiber-optic networks, satellite down-links and even standard VCR tapes, campuses

and departments are broadcasting classes and content to new clientele at new locals.

INFORMATION TECHNOLOGY AND CAMPUS CHANGES

Of course, these four examples barely touch the movement of IT into the course syllabus: slowly, cautiously, and somewhat erratically, growing numbers of faculty are bringing IT into their instructional activities. The early adopters are already using commercial products, creating their own templates, making assignments that draw on course materials distributed by educational publishers, and using simulations across a variety of disciplines to encourage the "active engagement in the construction of knowledge" described by Kozma and Johnson. But these early adopters may represent no more than a fifth of the professoriate; integration and innovation that goes beyond this group has been stalled.[10]

Nonetheless, the campus community harbors great expectations for more — more that will be better, richer, and less expensive, if not free — or at little cost to individual users. The initial experience with the Internet as a source of content for instruction and scholarship is striking — and positive. The rich array of periodicals, data bases, scholarly literature, image libraries, federal and state documents, and scientific research coming on-line on a daily or even hourly basis is stunning — and fundamentally changes the traditional definition of the library as the primary campus archive or information repository. Via both campus networks and broadly available commercial services users have access to a wide range of commercial, scholarly, and scientific resources concurrent with (or even prior to) the publication of these materials in printed form. Moreover, archival searches are quick and are becoming increasingly easy. On some of the commercial services, searching special topics and content in back issues of *Time*, *Newsweek*, *Scientific American*, *Atlantic Monthly*, and *The Congressional Record* can be done in the time it takes to walk from a parking lot, dorm room, or faculty office to a campus library.

The emerging uses of the Internet by faculty and students, especially the new practice of using e-mail to enhance communication among students and faculty in conjunction with the work of a specific course, may provide ways to change the structure of the fundamental "business" of education. Institutions may discover that small pockets of faculty and students are already making a transition to stages 3 and 4 in the use of information technology for teaching and learning.

Colleges and universities still have much to learn about how to develop a new information technology infrastructure that provides instructional and curricular benefits. We must measure our great aspirations and institutional investments against what information technology can really provide, not what we hope (or fear) it might do.

For today and into the realistic future, most students at most colleges will continue to pursue campus-based and classroom-defined educational experiences. The technology not withstanding, instruction in virtually all these classrooms will continue to depend primarily on faculty.

CONTENT, ACCESS, AND PRODUCTIVITY

Clearly, information technology can support changes in the traditional faculty role. Growing numbers of faculty are gaining experience using the Internet for collaborative discourse in their disciplinary specialties and for pursuing their own research agendas; however, very few have begun to train their students in these same skills. In many instances, students who have grown up with computers in their homes are training the faculty. As noted above, navigating the network now provides access to resources previously not available to most students (and perhaps to many faculty). This shift reflects a dramatic change in kinds of learning resources that can come into the classroom — dramatic shifts in the *content* available for instruction. And *content* — the material used to stimulate learning, analysis, synthesis, integration and mastery — combined with new modes of *communication*, provides the new foundation for education's great aspirations for information technology.

What IT does best (or will do better as it improves) is deliver *content* and *provide access* to information and to other people. It allows students and faculty to find and manipulate information, to take new meaning, and to have new (learning) experiences. In the near term, however, the demand for faculty guidance and intervention, for faculty mentoring, is much more likely to increase than to decrease. Students will continue to need faculty to provide the conceptual framework and motivation that enable them to seek and integrate new information. They will also need someone to introduce them to the most effective ways to approach the Internet for the purposes of acquiring information for a particular academic discipline.

But what then about the new Grail of productivity? There is little if any evidence that information technology will reduce faculty involvement in instruction (i.e., reduce the cost of instruction) in the next few years. Technology enhances the content of the curriculum, the materials that faculty use as a catalyst for learning; it also enhances the options for communication with and among students. Technology can help faculty adjust the syllabus to respond to changing issues and environmental opportunities, be these the shifting maps of Eastern Europe or the human genome. Admittedly, there are exceptions, most of which center on "skill-heavy" applications: the use of computer-based instruction for introductory logic and other courses has effectively altered some components of the course syllabus and the need for the faculty role in some instances, but these courses are still quite the exception after twenty years of demonstrated effectiveness.

Perhaps the changing demographics of higher education's clientele — the growing population of non-residential, part-time, older students — will continue to make distance education an attractive option. Consequently, some instructional uses of information technology will be more widely sought and acceptable. But higher education will be shaped by two demographic forces over the next decade: rising numbers of baby-boomers who are coming back to campus for additional education, coupled with a tidal-wave of the children of the baby-boomers (Boom II), making their first appearance on campus. Parent and child will not

necessarily want, need, or appreciate the same kind of instructional methodology.

AN EDUCATIONAL FRAMEWORK

So what do we advocate and what can we hope for? What are reasonable aspirations for information technology if campuses cannot realistically expect their technology investments to reduce the costs of instruction in the next few years?

We suggest that each college and university engage in an institution-wide planning initiative that looks carefully at the ways information technology can be used most effectively to improve teaching and learning. This review must also include a careful assessment of the full costs (hardware, software, faculty time, support services) and potential benefits of various alternatives. The American Association for Higher Education's Teaching, Learning, and Technology Roundtable (TLTR) Program has developed a promising framework for setting and achieving realistic goals in this arena. This approach recognizes four basic categories of IT benefits that differ significantly in the kinds and levels of faculty support services required.

I. Personal and institutional administrative productivity.
II. Enhancing traditional teaching.
III. Changing pedagogy.
IV. Changing content.

The first category, *individual productivity*, reflects IT applications that have no direct effect on the teaching or learning experiences of current faculty or students. Word-processing, spreadsheets, and electronic mail are good examples of individual productivity. So too do automated course registration systems. These are examples of productivity gains that have minimal impact on what or how things are taught and learned. Faculty support services needed in this category are primarily technical, largely introductory training, plus hardware and software maintenance.

Campus efforts to *enhance traditional teaching* (category II), include the broad effort underway at campuses across the

country to "wire" classrooms with computers and projection devices. Showing a rotating 3-dimensional image of a molecule or cross-section of a human brain adds to the quality of content and communication in class without necessarily changing the underlying teaching approach or curriculum. Faculty support services needed in this category are primarily technical: introductory training and hardware maintenance, plus discipline-specific or course-specific guidance about the availability and acquisition of computer-based materials.

Changing pedagogy, the third category, draws on many issues raised by Kozma and Johnston, cited above. Good examples here include supplementing science experiments with computer-based simulations or the use of networked computers to exchange drafts and editorial comments in English composition courses. Additionally, this category might also include distance education initiatives, which must acknowledge the difference between students being present in a conventional classroom and participating via telecommunications. Faculty support services needed in this category include the technical: introductory training and hardware maintenance. However, discipline-specific or course-specific guidance about the availability and acquisition of computer-based materials is essential. Also important is the availability of introductory and training materials and services to enable faculty members to understand how they can modify their course preparation and conduct. As faculty pursue these options more extensively it also becomes necessary to involve other campus services such as the library and bookstore in helping to find, select, and make available for convenient and effective student use new combinations of traditional books and reprints and new media such as computer software, CD-ROMs, and Internet access.

The fourth category, *changing content*, represents the "final frontier." In some disciplines the use of information technology in the research and field work has already changed how scholars think of their work and the focus of their activities (e.g., textual analysis, mathematical proof by exhaustion of all options). In other areas, scholars have discovered that information technology now permits them to represent and manipulate information and ideas in ways that were nearly

impossible previously (e.g., Geographical Information Systems, theatrical lighting designs, musical notation and performance). In both cases, scholars believe they must teach the "new" material and that they must engage their students in using the relevant technology. In this context, IT becomes both the reason for and means of changing curriculum content. Faculty support services needed in this category are even beyond those described for category three. Faculty need to be working with publishers, disciplinary associations, and peer-groups to revise the curriculum and make sure teaching and learning materials reflecting the changes in content and use of technology are appropriately available.

And what about productivity? It is only in category one in this framework where productivity gains (reduced costs, enhanced quality, broader access to learning) are readily achievable. The other categories offer improvements and increased value, but usually in conjunction with substantially increased investment and support costs. In sum, there is still no instructional equivalent of the calculator replacing the slide-rule. Electronic mail, however, may come close. E-mail has the potential for becoming an enhancement for communication between faculty and students and among students in support of a wide variety of instructional approaches. When personal computers are able to convert speech to text rapidly and accurately, and electronic mail (or whatever it is called at that time) becomes even easier to use, the combination will add a new dimension to teaching and learning. There are already numerous examples of creative use of electronic mail to improve teaching and learning by faculty members and students who do *not* perceive what they are doing as a significant technological achievement. They think they are using a mundane technology for modest gains — that requires very little *apparent* external support service.

Chapter 6.
Distance Learning

The most certain long-term conclusion is that different combinations of technology and pedagogy work best for different combinations of students and faculty.

No discussion of information technology would be complete without considering the distance learning applications. To some observers of higher education, information technology has been a solution searching for a problem. Increasingly, distance education seems to be the problem searching for information technology. Indeed, "distance learning" or "distance education" are terms lacking precise definitions and denote a topic likely to get immediate emotional reactions from faculty and academic administrators.

Under the name of "distance education," different campuses are exploring very different approaches, ranging from two-way interactive live video to electronic mail. For purposes of discussion, let us define "distance education" as including any form of teaching and learning in which the teacher and learner are not in the same place at the same time and for which some form of electronic telecommunications is used.

Many administrators are (wrongly) enthusiastic about distance education as the best hope for increasing tuition revenues faster than instructional expenses in the next few years. Many faculty are (wrongly) afraid that distance education is simply an administrator's plan to use technology to eliminate faculty jobs. So far, significant cost savings, revenue growth, and faculty replacement occur only in rare implementations of distance education — usually where the instruction is narrowly focused on students' mastering parts of a well-defined knowledge base or specific skills. In most conscientious, successful efforts to use distance education, the effective educational reach of the institution is extended and the quality of learning improved; but associated costs almost invariably go up as does the need for faculty preparation and support. What

also changes is the configuration of professionals, including faculty, needed to provide quality education to a given group of students.

IMPETUS TO ADOPTION

So, what is the primary force driving this new interest in distance education and the efforts to link it to the technologies (video, e-mail, multimedia) that are gaining growing acceptance across higher education? Some will argue that distance education offers a way for individual institutions to expand capacity absent new investments in bricks and mortar. Some distance education advocates believe that this may be the only way for United States colleges and universities to address the rising demand for postsecondary education and certification during the 21st Century.

A second group of distance education advocates views the marriage of distance education and information technology as a cost-effective vehicle to enhance the effectiveness of older non-electronic distance education initiatives. Video, e-mail, and multimedia bring to the remote learner a richer learning experience than one defined by "home study" based on printed materials and limited interaction with other learners.

Some educators are beginning to view technology-based distance education as offering a mode of learning that may be superior as a replacement or supplement for some students, students with certain combinations of learning styles, motivation, and self-discipline. These educators see distance education as making learning more accessible — geographically, logistically, and pedagogically — to a wider range of students. With increasing frequency, faculty report that students enrolled in "traditional" sections of a course are requesting access to videos and other materials that were developed primarily for "distant" sections. Most practitioners of distance education report concern about students who opt for this approach with unrealistic expectations; they may not understand the increased level of self-discipline required of students for success in most currently popular forms of distance education. Retention rates must be watched carefully, and adequate

student guidance must be provided.

Finally, there appears to be a fourth group of distance education advocates who believe that the marriage of distance education and information resources will reduce instructional costs and increase institutional revenues. For these advocates, distance education provides the prospect of a cost-effective mechanism to build a catalog of core courses that might serve selected clientele at reduced cost. In some states, distance education appears to offer a viable way to meet mandates to provide some kinds of higher education accessible to some portion of potential students.

CONTENT, CONTEXT, AND CERTIFICATION

Central to any assessment of the proposed role and impact of distance education is an understanding of the role of information technology in the teaching function in postsecondary education. This brings into focus the core teaching issues of *content*, *context*, and *certification*. Without question, distance education has important impacts and consequences on all three dimensions.

Clearly, distance education affects the *content* of the course accessible to some students. It expands access to a rich array of materials not limited to the printed page or the current faculty of the individual college or university. For distance learners, this might range from taped lectures to a WWW-based home page of supplemental content and annotations.

Most obviously, distance education affects the *context* of the learning experience, where and how learning occurs as well as the interaction between student and faculty and also the important interaction among students — e.g., electronic mail and other forms of video telecommunications and computer-mediated communication.

Finally, in this age of rising interest in and concern about quality and assessment, information technology's role in distance education also has significant consequences for *certification*. This ranges from computer-based testing modules for specific content, to "final exams" taken on-line and using techniques emerging from research in artificial intelligence and adaptive testing.

CAVEATS

Many institutions too quickly commit to a particular technology and pedagogy — when other options remain to be explored and compared — and distance education is no exception. The most certain long term conclusion is that different combinations of technology and pedagogy work best for different combinations of students and faculty. Investing heavily and quickly in one of these combinations may give an institution an advantage in offering a certain form of distance education that may be highly attractive and effective for certain kinds of students (based on their learning capabilities, preferences, motivation, habits). This could result in certain kinds of students being pulled toward certain kinds of institutions, where the match works best. But if the investment is too large, other options may be simultaneously closed off.

Perhaps the most exciting and unpredictable new technology for distance education is the World Wide Web (WWW). A very small but growing number of faculty are beginning to create their own WWW "home pages" and to use these information spaces as vehicles to make available information to their students in conjunction with a course. Unless these faculty members or their institutions take great pains otherwise, the course material thus made available is immediately accessible to anyone with reasonable access to the WWW. These faculty can immediately, intentionally or unintentionally, offer a form of instruction to individuals all over the world. These individuals may or may not have any formal relation with the institution that pays these faculty a salary for developing and delivering instruction.

Distance education may be either the first step toward dramatically more accessible education of higher quality or the Pandora's Box for educational uses of information technology. In times of political and economic stress for colleges and universities, distance education unleashes both the potential to expand access and capacity, as well as the fear of an uncertain work environment, unknown costs, and unknown consequences. So far, too few institutions are developing funding and implementation strategies that are realistic about the need

for support services, transition processes, and enough time to develop high-quality distance education.

Finally, it is easy to justify exploring new options for the format and delivery of distance education to provide better educational access for more students — and more *kinds* of students in these days of rapidly changing student demographics. However, too many institutions are grasping at what appears to be an unbounded source of new revenue — students who cannot or will not attend classes on campus. This new source is not really unbounded. As the number of institutions pursuing these "new" students increases, the number that any single institution can expect to capture will rapidly diminish. Competition among colleges and universities may very well increase, and in an arena for which most have little preparation.

Chapter 7. Conclusion

This review suggests that content, curriculum, and communications — rather than productivity — are the appropriate focus of and rationale for campus investments in IT. But even if this argument is compelling, we must still be careful not to foster inappropriate expectations. IT enthusiasts must avoid irritating too many people by making too many promises that cannot be kept. Technology advocates must sustain the good will and realistic expectations of a wide audience of information consumers and providers so that all participants in the educational enterprise will be, at minimum, cautiously receptive when the next course-specific application of great potential comes along and when the first great across-the-board instructional tool arrives.

There is also still much to learn about the costs and benefits associated with bringing a group of people into the same place (classroom) at the same time vs. having them interact using computers, video, and telecommunications. Each institution, department, and faculty member must find the right balance in forming combinations of traditional practices and materials with new ones.

These are important issues for higher education. Advocates and evangelists must make promises carefully, managing both expectations and limited financial resources with great care. We must be honest with ourselves, our sponsors, and our clientele about the applications and limits of information technology. The academic enterprise can do great things with information technology and will experience significant benefits from it. But the transition won't be cheap, and it will not save money soon. The IT investment, however, will make a qualitative difference in the way we teach, the materials we teach with, the structure of the college curriculum, the learning experience for students, and how we exchange information — both as colleagues and also as faculty interacting with students. Goals and aspirations for quality and academic productivity will be achieved only over many years and only through

developing and providing the right combinations of:

- individualized, interactive access to information for students and faculty;
- guidance and support for and from faculty; and
- social context within an educational institution or a "learning community."

These are not small challenges. But they are also important challenges which higher education must address with realistic expectations and objectives, mindful about real costs, attentive to the capacity to deliver, and focused on the needs of an increasingly heterogeneous clientele in a rapidly changing world.

Footnotes

[1] Over 30 years ago, Professor Patrick Suppes of Stanford University wrote "Both the processing and the uses of information are undergoing an unprecedented technological revolution. Not only are machines now able to deal with many kinds of information at high speed and in large quantities, but it is also possible to manipulate these quantities so as to benefit from them in new ways. This is perhaps nowhere truer than in the field of education. One can predict that in a few more years millions of schoolchildren will have access to what Philip of Macedon's son Alexander enjoyed as a royal prerogative: the services of a tutor as well-informed and as responsive as Aristotle."

[2] This and several other generalizations in this monograph are based on survey results, observations, interviews, conversations, and arguments in response to Steven W. Gilbert's presentations and consultations of the past several years,including presentations at the NEA National Higher Education Conference. During the most recent 12 months, Gilbert has participated in more than 20 campus visits, 20 conference presentations, 10 formal meetings, and many conversations with faculty, administrators, publishers and representatives of the information industries — including an almost daily Internet conversation on related topics via the AAHESGIT Listserv. The more useful survey results come from the work of Kenneth C. Green.

[3] There is ample and in some ways distressing evidence that traditional cost/benefit analysis and cost accounting models for instructional activities are difficult if not impossible for most institutions. Howard Bowen's important, but too-often unheeded, work on the costs of higher education (1980) provides compelling evidence that colleges and universities do not allocate resources in seemingly rational or orderly ways: instructional costs vary widely across seemingly similar types of institu-

tions, as measured by mission, status, and clientele.
For a more detailed analysis of the issues related to enabling a wide range of faculty beyond the self-starting "early adopters" to use new applications of information technology in their teaching, see "Stuck at the Barricades," by William Geoghegan, *Change* (March-April) 1995.

[5] A. W. Astin, et . al. *The American Freshman: National Norms for Fall 1994.* Los Angeles: Higher Education Research Institute, UCLA. 1994.

[6] Robert Kozma and Jerome Johnston. "The Computer Revolution Comes to the Classroom." *Change* (January-February, 1991).

[7] Kozma and Johnston, pp.16-18.

[8] "Final Report." American Library Association Presidential Committee on Information Literary. January 1989.

[9] Data from the annual campus computing report reveals that barely one-fifth of the nation's colleges and universities have a plan to "acquire and retire" technology resources. Rather, most deal with technology planning and purchases in an opportunistic manner. See Kenneth C. Green, *Campus Computing, 1994.* Los Angeles: University of Southern California. 1995.

[10] See Geoghegan, "Stuck at the Barricades."

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